Estimation of dominance effects for reproductive, growth and carcass traits of Pannon White rabbits

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ABSTRACT

Authors analysed the reproductive, growth and slaughter records of Pannon White rabbits based on records collected between 1992 and 2014. The examined traits were: average daily gain (ADG), thigh muscle volume (TMV) and litter weight at day 21 (LW21). Genetic parameters were estimated using basic and extended (with dominance effects) single trait animal models using the REML procedure. Heritability estimates ranged between low and moderate for all traits (ADG: 0.25-0.3±0.01, TMV: 0.21-0.24±0.02-0.03, LW21: 0.07-0.19±0.01). Random litter effects were moderate for ADG (0.24-0.25±0.01) but were low for TMV (0.09-0.1±0.01-0.03). Magnitude of permanent environmental effects exceeded that of the heritability values for LW21 in most models. Applying the extended complete models dominance effects were low for ADG and TMV (0.03±0.01-0.02) and moderate for LW21 (0.23±0.01). Among the estimated genetic correlation coefficients, the observed negative value between ADG and TMV (-0.31±0.03) and between TMV and LW21 (-0.38±0.13) were unfavourable. Based on the different models the estimated breeding values showed high stability as their rank correlation coefficients were close to unity (0.93-0.99).

Keywords: breeding value stability, dominance, extended models, rabbits

INTRODUCTION

In the course of genetic evaluation nonadditive components are ignored in most cases. The reason for this simplification is that the computing capacity of the extended models is large and consequently running times may be substantial. Thus, their application in practice may not be straightforward. The objective of this present study was to evaluate the most important traits of the Pannon White rabbits using the basic and extended animal models in order to evaluate the application consequences related to selection.

MATERIALS AND METHODS

The present study was based on performance records collected between 1992 and 2014 at the experimental rabbit farm of the Kaposvár University. The analysed traits were average daily gain between the ages of 5 and 10 weeks (ADG), thigh muscle volume (TMV) measured by Computer Tomography (CT) and litter weight at 21 days of age (LW21). Descriptive statistics of the examined traits are given in Table 1. Genetic parameters and the breeding values for all traits were estimated using the VCE6 software (Groeneveld et al., 2008) running single trait and three trait models. The structure of the applied models could be sorted to two groups, basic and extended models.

Table 1. Descriptive statistics for the traits

Trait	N	Mean	Std
ADG (g/day)	125,511	40.9	7.4
TMV (cm^3)	6,369	334	37.8
LW21 (kg)	18,973	2.65	0.66

ADG - average daily gain; TMV - thigh muscle volume; LW21 - litter weight at day 21.

The basic model for LW21 was:

$$y = Xb + Za + Wpe + e$$

where:

y = vector of phenotypic observations, b = vector of fixed effects, pe = vector of individual permanent environmental effects, a = vector of additive genetic effects, e = vector of residuals, X, Z, and W incidence matrices relating records to fixed, permanent environmental and additive genetic effects.

For ADG and TMV:

$$y = Xb + Za + Kc + e$$

where:

c = vector of random litter effects, K incidence matrix relating records to random litter effects.

Other terms were the same as previously.

The extended models also contained dominance effects via the family class effect. In the first type of the extended models for LW21, ADG and TMV the dominance effects replaced either the permanent environmental or the random litter effects:

$$y = Xb + Za + Uf + e$$

$$y = Xb + Za + Uf + e$$

where:

f = vector of family class effects, U incidence matrix relating records to family effects.

In the second type of the extended models the dominance effects extended either the permanent environmental or the random litter effects:

$$y = Xb + Za + Wpe + Uf + e$$

$$y = Xb + Za + Kc + Uf + e$$

where all terms were the same as defined above.

Besides the already mentioned random effects the different animal models contained sex (ADG, TMV), year-month (ADG, TMV, LW21), parity (LW21), age of the kits at measurement (LW21) and litter size at day 21 (LW21).

RESULTS AND DISCUSSION

The estimate genetic parameters for the analysed traits are presented in Table 2. Looking the estimated heritabilities based on the different models it can be stated that they were relatively stable irrespectively of the presence or absence of the dominance effects. TMV showed moderate heritability values which were in accordance with the results of Gyovai et al. (2012) and Nagy et al. (2013a). The only unfavourable characteristic of CT based measurement is that it is relatively expensive. For this reason, French authors tried to replace CT by ultrasound device (Lenoir and Morien, 2016). For the surface of the *m. longissimus dorsi* they observed a similar heritability (0.2) reported here for TMV but they also estimated a favourable genetic correlation between the muscle surface and dressing out percentage (0.74). In Table 2 it can be seen that random litter effects had not substantially influence TMV which result was also reported in previous studies (Gyovai et al., 2012; Nagy et al., 2013a). The estimated heritability values for ADG were somewhat higher than observed for TMV. The magnitudes of random litter effects were also moderate. These results were also in accordance to previous finings (Gyovai et al., 2012; Nagy et al., 2013a).

Looking the reported values of other breeds similar heritabilities were reported for Spanish breeds (Mínguez et al., 2016). LW21 had the lowest heritabilities among the examined traits and the permanent environmental effects exceeded that of the additive genetic effects. The observed values were within the range of previous results and results of other authors (Al-Saef et al., 2008; Gyovai et al., 2012). The extended models contained also dominance effects either replacing or extending the other random effects used in the analysis (Table 2).

Table 2. Genetic parameters of the traits

Trait	Parameter	ADG	TMV	LW21
3	h^2	0.25±0.01	0.24±0.02	0.08±0.01
1		0.3±0.01	0.21±0.03	0.08±0.01
1		0.33±0.01	0.21±0.03	0.19±0.01
1		0.3±0.01	0.21±0.02	0.07±0.01
3	c^2	0.25±0.01	0.09±0.01	-
1		0.25±0.01	0.1±0.02	-
1		-	-	-
1		0.24±0.01	0.09±0.03	-
3	Pe	-	-	0.17±0.01
1		-	-	0.17±0.01
1		-	-	-
1		-		0.15±0.02
1	d^2	0.74±0.01	0.27±0.01	0.42±0.01
1	d^2	0.03±0.01	0.03±0.02	0.23±0.01

ADG - average daily gain; TMV - thigh muscle volume; LW21 - litter weight at day 21; h^2 – heritability; c^2 - magnitude of random litter effects; Pe - magnitude of permanent environmental effects; d^2 - magnitude of dominance effects.

The estimated dominance effects were large for ADG and LW21 and it was moderate for TMV in case dominance effect was the only random factor beside additive genetic effects. However, when dominance effect only extended the models used in the breeding programme the magnitudes of the dominance effects became small for ADG and TMV and it was moderate for LW21. In this case other random effects showed only small changes compared to the basic models. The phenomenon where including a random effect lead to substantial changes in other effects is called confounding and it was discussed in detail by Nagy et al. (2013b). Nevertheless, in this study it was only observed when dominance replaced other random effects. Apart from earlier studies (Nagy et al., 2013b; 2014) where relatively small dominance effects (0.05-0.08) were reported for litter size traits there are very few dominance estimates are available in rabbits. In a recent study Fernández et al. (2017) published small dominance effects (0.02-0.03) for litter size traits in Spanish rabbit lines. Their smaller estimates could be the results of their different computing approach. The estimated genetic correlation coefficients among the analysed traits are provided in Table 3.

According to the estimated genetic correlation coefficient between ADG and TMV from the breeding viewpoint it is unfavourable. Similar results were reported by Nagy et al. (2013a) and Gyovai et al. (2012) who analysed the data of the Pannon Large and Pannon White rabbits, respectively.

Table 3. Genetic correlation coefficients among the traits

ADG-TMV	ADG-LW21	TMV-LW21
-0.33±0.05	0.25±0.05	-0.38±0.13

ADG - average daily gain; TMV - thigh muscle volume; LW21 - litter weight at day 21.

On the contrary the positive genetic correlation between ADG and LW21 is favourable. At present the Pannon White rabbits are selected in a two steps procedure where in the first step 10-week-old rabbits are preselected according to the average LW21 BLUP values of their parents. LW21 replaced ADG as a selection criteria trait in 2010. The moderate genetic correlation coefficient between TMV and LW21 is not favourable. It can be speculated that the long CT based selection may have decreased the body reserves and it is well known that energy deficit in rabbit does may lead to a decreased reproductive performance. This problematic point is tried to be solved recently by Ács et al. (2018) who constructed selection indices for Pannon White rabbits making the selection procedure more economically sound.

The predicted breeding values based on the different models showed high stability for all traits regardless of the inclusion or on the absence of the dominance effects. The correlations were especially high for ADG and for TMV (0.98-0.99) but also for LW21 the calculated values were close to unity (0.91-0.96). Similar results were received by Nagy et al. (2014) for different litter size composite traits in Pannon White and in Pannon White Large rabbits using single trait models. However, Nagy et al. (2014) also analyzed two trait models including dominance and, in that case, the observed breeding values stability substantially decreased (0.38-0.79).

CONCLUSIONS

Due to the very high breeding value stability application of the conventional animal models without dominance effects can be advocated. Nevertheless, it has to be kept in mind that in real breeding programs generally multi trait models are used.

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